Low-Emissions Burner Technology using Biomass-Derived Liquid Fuels

Saving energy and reducing emissions with fuel-flexible burners

This project will develop fuel-flexible, low-emissions burner technology capable of using biomass-derived liquid fuels, such as glycerin or fatty acids, as a substitute for natural gas, thereby reducing energy consumption, lowering greenhouse gas emissions, and increasing fuel flexibility.

Introduction

The metal processing industry, one of the most energy-intensive manufacturing sectors in the United States, commonly uses natural gas in industrial process heating and boilers. Although natural gas is a clean, high-energy fuel source, it has been subject to price volatility in recent years.

Biomass-derived liquid fuels, including the byproducts of biodiesel production, present a viable alternative to natural gas for process heating applications. Two byproducts of biodiesel production are glycerin and fatty acids. Glycerin is a colorless, odorless, viscous liquid with thousands of uses in its pure form. The glycerin created in biodiesel production, however, is in a crude form and has little commercial value today. Crude glycerin contains significant energy, but its high viscosity at room temperature and high auto-ignition temperature make it difficult to burn using the standard fuel injectors found in fuel oil burners.

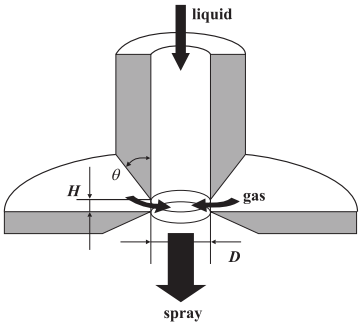

Figure 1

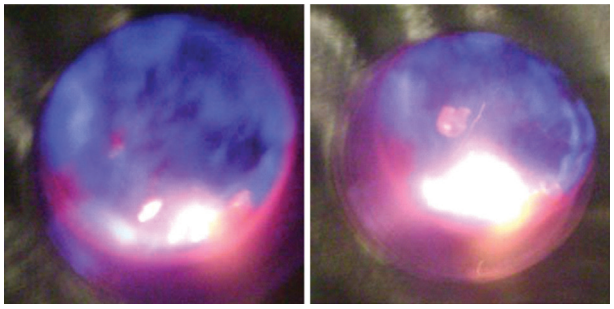

Figure 2

Figure 1. Schematic of the flow-blurring injector
Figure 2. (Left) Flame from methane co-fired with glycerin (Right) Pure glycerin flame stabilized on porous inert medium

This project will develop fuel-flexible burners operating on biomass-derived liquid fuels with low carbon emissions. The burner system will primarily use glycerin or fatty acids, but is expected to offer the flexibility for use with other high-viscosity fuels such as pyrolysis oil or vegetable oils. The project will employ two newly developed combustion techniques to atomize the crude glycerin effectively: porous inert media combustion and a flow-blurring injector. Having overcome the challenges associated with glycerin/fatty acid combustion, the project will result in a commercial product for biodiesel producers, boiler operators, and the metal casting industry.

Benefits for Our Industry and Our Nation

Manufacturing industries consume approximately one-third of the national energy budget. The development of fuel-flexible, low-emissions burners to displace natural gas with biomass-derived liquid fuels will produce significant environmental, energy, and economic benefits. Commercialization of this technology has the potential to achieve the following:

- Reduce energy consumption
- Lower greenhouse gas emissions by using renewable fuels
- Convert a waste stream of biodiesel production into a value-added commodity, increasing the revenue of the biodiesel industry
- Enable the metal processing industry to hedge against the price volatility of natural gas

Applications in Our Nation's Industry

The fuel-flexible burners will be used initially in the metal processing industry (e.g., aluminum and steel) to reduce natural gas consumption, but could also become viable alternatives for other industries that use boilers and process heating systems, including biodiesel processing plants.

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Project Description

The project goal is to develop fuel-flexible burner technology for the metal processing industry using biomass-derived liquid fuels in place of natural gas. Using varying grades of crude glycerin, new combustion techniques will be used to investigate net carbon emissions and heat release rates.

Barriers

- Input quality of crude glycerin, as its composition can differ widely depending on the process used in biodiesel production
- Degree of standardization of the biodiesel refining process, as production regulations are not always consistent
- Replication of low-emissions lab test results in a large-scale, industrial burner system

Pathways

The project will be structured in four research and development stages. In stage one, extensive research will be conducted to define the low-emissions burner concept. In stage two, a lab-scale burner will be designed and tested using different fuel grades of glycerin and fatty acids. Based on these test results, stage three will involve a scale-up of the prototype burner system for use at a pilot test site. In stage four, the pilot system will be designed, optimized, built, and tested at an aluminum processing company, and the pilot burner will be evaluated for net carbon emissions and heat release rates.

Milestones

- Evaluation of a fuel-flexible, low-emissions burner concept at laboratory scale
- Demonstration of low nitrogen oxide (NOx) and carbon monoxide (CO) emissions in lab experiments
- Development of a prototype burner system to test biodiesel byproducts from different biodiesel facilities
- Construction of a pilot-scale burner system for testing and demonstration at an industrial site, with the goal of evaluating the net carbon emissions and heat release rates

Commercialization

Several industrial partners are participating in the project and will contribute to the successful commercialization of the novel burner technology.

Wise-Alloys, an aluminum processing company, has committed to partially cost-share in the project and assist in technology development and field verification. Leading biodiesel producers will provide industrial oversight and supply different grades of glycerin and fatty acids for laboratory tests. Industrial partners will be consulted to identify potential natural gas replacement opportunities in the steel casting industry using the new technology. Industrial burner designers will be consulted for help developing pilot-scale and commercial-scale burner products.

Project Partners

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July 2010